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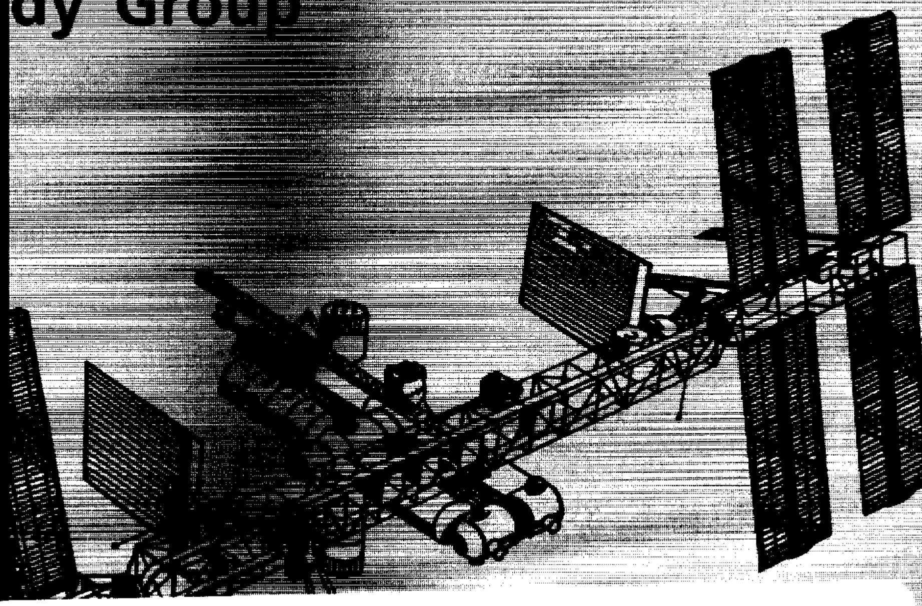
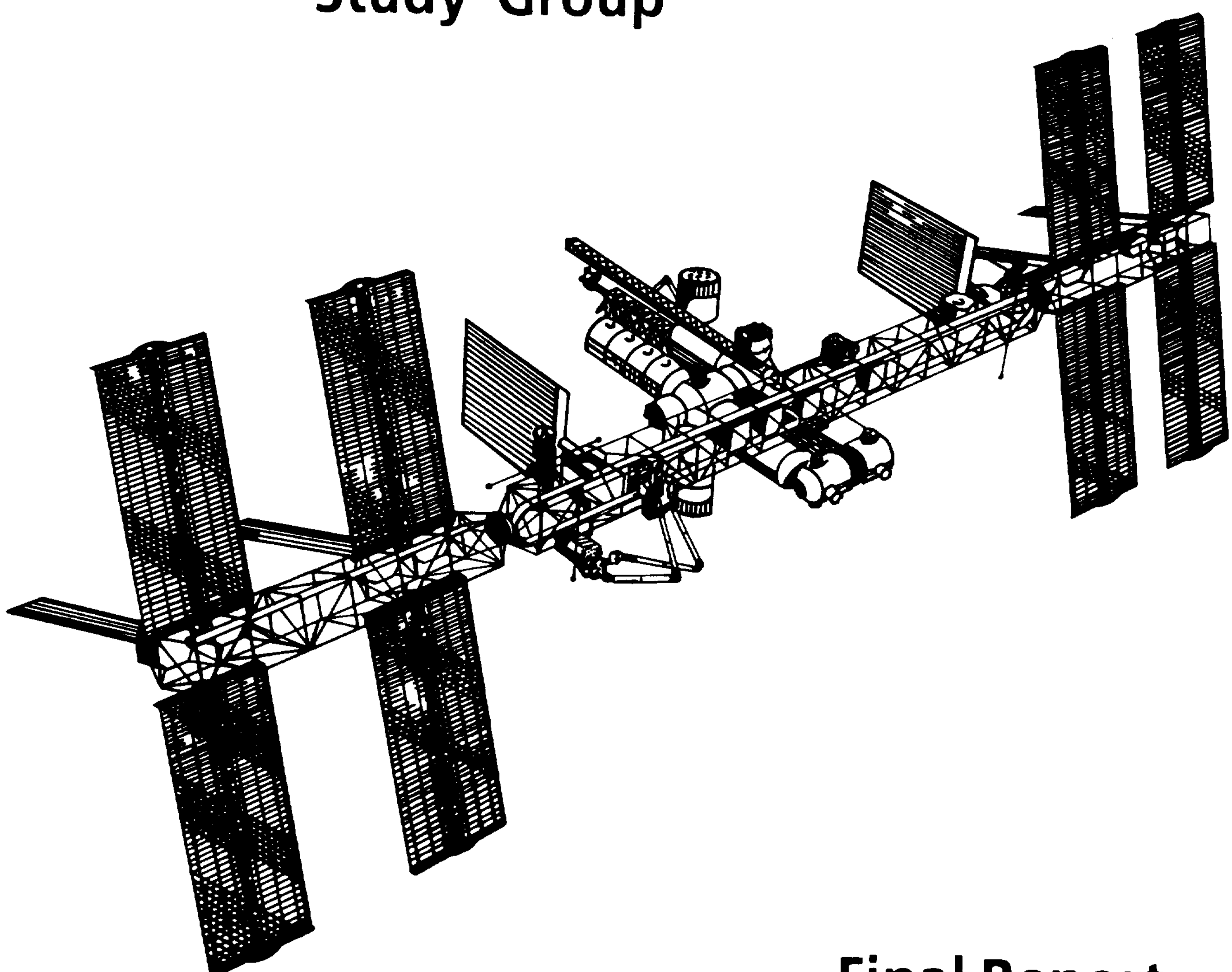


NASA
National Aeronautics and
Space Administration

Space Station "Quick is Beautiful" Research Study Group



Final Report
April 1988

PREFACE

The charter of the Space Station "Quick is Beautiful" Study Group was to examine whether the Space Station planned by NASA to be operational in the mid 1990s could enhance the nation's ability to conduct an important class of space research activities, and to make recommendations to the Associate Administrator for the Office of Space Station regarding implementation of operational and/or hardware mechanisms to permit effective use of Space Station for this type of research. These activities, popularly referred to by the phrase "Quick is Beautiful" (QIB), involve small-to-moderate size space experiments that can be developed quickly and inexpensively, and which in some cases need relatively rapid initial deployment and/or reflight.

The Study Group consisted of individuals from NASA, NSF, NIH, and from industrial space research firms. The Study Group met four times over a period of 18 months.

A small number of top-level requirements that must be met by the Space Station Program if it is to provide this now missing attribute to the civilian space program were identified by the Study Group. The Group also examined and made recommendations with regard to activities that NASA should undertake in preparation for Space Station operations, emphasizing use of the Space Shuttle/Spacelab system as a testbed.

The Study Group drew heavily on operational experiences gained from existing ground-based (e.g., NASA wind tunnels, NSF Antarctic research stations) as well as from previous space- based research facilities. The HITCHHIKER, SPARTAN and GAS programs in the Shuttle were particularly useful as precursors of the QIB concept.

The Study Group wishes to express their appreciation to Dr. George Ricker of M.I.T. and to Mr. Robert Staehle of JPL. Dr. Ricker is chairing the Small Attached Payloads Working Group for NASA's Office of Space Science and Applications, and he shared with the Study Group preliminary findings of that Working Group. Mr. Staehle briefed the Study Group on the findings of two JPL studies concerning lessons learned from operation of the Space Shuttle for the conduct of space research, and he provided additional personal insight which the Study Group found useful in its deliberations. Special thanks are due also to Dr. William Raney of the Space Station Office. His penetrating questions and comments helped crystallize and refine much of what is in this Report.

I. EXECUTIVE SUMMARY

A balanced, healthy national program of basic and applied research, be it ground- or space-based, ranges in character from efforts involving individuals or small groups of individuals using relatively small-scale and low-cost research facilities, to efforts involving large teams of researchers and/or major national research facilities. The former type of effort as conducted in the space arena is popularly referred to by the phrase "Quick is Beautiful", or "QIB" for short.

A wide range of research communities would benefit from a viable QIB capability within the space program. The nation's universities are beginning to see the effects of the absence of flight opportunities on the number and quality of students that are choosing space research as careers. If we are to ensure that there is an adequate flow of trained personnel into industry, government, and academia we must make space research accessible to university Principal Investigator researchers with flight (and reflight as necessary) opportunities on time scales commensurate with the duration of graduate student thesis projects.

In the area of commercial research there is a crucial need for "proof-of-concept" flight opportunities. Here it is important to be able to fly prototype hardware and to be able to refly that hardware as needed to demonstrate whether a particular process or hardware concept is sufficiently viable to proceed to the next phase of a commercial R&D process. Here again the timescale is of order one to two years from initiation of a project to gathering of flight data.

Among the areas of space research that will be enabled with the permanent presence of humans on orbit are the laboratory-oriented experimental activities which have strong ground-based counter- parts. This means that it will be essential to streamline procedures and costs for innovative research ideas to make it attractive for leading researchers to invest their time and the time of their research staffs (again graduate students are important) in space research projects. Also, as many of the leading researchers in these disciplines are not currently funded by NASA, but by agencies such as NIH and NSF, it is important that interagency ties and communication be strengthened.

The Space Station can be a pivotal component of this nation's space infrastructure in a variety of areas ranging from human exploration of the Solar System to graduate student thesis research. Used in a creative way the Space Station can help relieve the "access to space" problem that currently plagues space research. A positive consequence of the unfortunate delays in the Space Station is that NASA has the opportunity to develop and implement planning for effective and exciting use of this valuable facility. Full implementation of a QIB philosophy into NASA's operational thinking would be an important step in revitalizing this nation's space research effort.

Principal Conclusions

The Study Group reached four overarching Conclusions.

1. The planned **Space Station**, with its unprecedented level of **on-orbit resources** (most notably crew, power, pressurized volume, and space for attached payloads), provides an **enabling** capability for the conduct of QIB research.

2. The concept of QIB can be implemented only if there is a **guaranteed availability of resources**, both on-orbit and in transportation to orbit.

3. The establishment of a user support infrastructure **dedicated** to QIB is required in order to implement effectively the QIB concept.

4. The QIB concept can be implemented effectively only for users placing a **minimal draw on system resources** and working to a **well-specified and rigorously controlled set of interfaces**.

Major Recommendations

It is strongly recommended that:

1. NASA enunciate an **Agency policy** (i.e., at the Administrator level) that **guarantees** the availability of **at least 5 percent of the total resources** of the Space Station and its supporting logistics system to the conduct of QIB research.

2. The Office of Space Station and the Office of Space Flight establish management structures that contain elements **dedicated** specifically to the support of QIB research on the Space Station and on the Space Shuttle.

3. A **standard** set of rigidly-controlled **interfaces** be developed and clearly documented for QIB payloads on the Space Station.

4. The NASA Space Station **user program offices** (Codes C,E, and R) **define** the classes of activity and general **technical requirements for QIB research** in their programs. These offices, in collaboration with the Office of Space Station, should develop a management plan for supporting a special QIB research queue for Space Station by the time of Space Station CDR.

Rapid implementation of these Recommendations is essential to a realization of the full potential of Space Station to advance the cause of space research in this country, and to gain valuable operational testbed experience using the STS.

II. THE NEED FOR QIB SPACE RESEARCH

In order to set the issues addressed in this study in context it is useful to examine briefly modes of conducting research at terrestrial facilities. Ground-based research ranges in character from efforts involving an individual or a small group of individuals using relatively small-scale research facilities, to efforts involving large teams of researchers and/or major national research facilities.

Two points are relevant about this wide range of research modes; it is a natural consequence of the diversity of research in general, and it is ongoing at any given time. Restating this latter point in a different manner, although the history of ground-based research is long and illustrious there remains a critical continuing need for small-scale research activities that are conceived, developed, and implemented at relatively modest cost and on relatively short(e.g., two year) time scales.

In contrast to ground-based research there is a clear trend in many areas of space-based research away from the small end of the research spectrum towards large, multi-instrument, multi-investigator research. The reasons for this trend are many, including increased understanding in a given area of research, and a relative paucity of flight opportunities. The former of these occurs in all research areas as one era of research pushes back the frontiers of knowledge necessitating a new generation of experiments and experimental equipment. However, the presence of this trend in ground-based research has not diminished the importance of small-scale research.

The latter reason is a unique attribute of space-based research and it has had a major influence on the nature of space research operations and facilities. Particularly notable in the context of this study is that it has led to a tendency to develop missions and facilities that are "all things to all people", with attendant high development costs and long intervals of time between mission/facility concept initiation to return of research data (many space research activities now involve a decade or more from beginning of a project to acquisition of first data). Additionally, this trend in space research leads to a small number of research facilities and opportunities and a correspondingly small number of researchers obtaining hands-on experience with space hardware.

An inevitable consequence if current trends in space research are left unchecked is that the nation will not train the next generation of professionals to develop innovative space facilities and instrumentation. Failure to reverse this trend will affect adversely the health of basic and applied research conducted at universities, government laboratories, and leading industrial research centers.

III. DEFINITION AND IMPLEMENTATION OF QIB RESEARCH

The types of research activity discussed here constitute a vital and integral component of any healthy research program. The absence of this type of capability from the nation's space program has become increasingly evident and has led to a number of debates as to the proper way to conduct space research. A strong champion of small and/or quick science in space has been Freeman Dyson who characterizes such research by the phrase "Quick is Beautiful" (QIB). This phrase (but not the program suggested by Dyson) has been adopted as the theme of this Study.

Given the general concerns raised above, the Study Group established the following to define broadly the features of QIB research:

QIB research is a means to:

- **minimize** the **time** from concept development to flight to data return for small-to-moderate size space research (time scales need to be commensurate with graduate student thesis and/or commercial proof-of-concept research, i.e., 2-3 years or less),

- **maximize flight and reflight opportunities** for the space research communities.

An important key to realizing these objectives is the extent to which QIB activity perturbs Space Station resources, interfaces, and management structure. The quantity of resources, complexity of interfaces, and level of management necessary for QIB is not nearly as important as whether significant changes in quantity, complexity, or level are required to accommodate QIB.

As an example, consider a hypothetical experiment which requires 20 cm of rack space, 100 watts of power, a 1200 baud RS232 communications link, and 5 minutes of crew time per day for 20 days with 2 hours of pre-flight training. If this quantity of resources has been generically reserved in advance for QIB payloads, then the particular experiment can be specified very late in the manifesting process. Even if the power level is a kilowatt and the baud rate is 9600, the experiment can be defined late in the process **if** resources are reserved. If, on the other hand, only 10 watts had been reserved and 100 watts can only be made available by replanning the phasing of other experiments and installing additional power capability in the rack, then the resource availability has been perturbed significantly. Similarly, if the communications link does not match exactly the RS232 and connector formats, then the communications interface must be altered resulting in significant interface changes. Finally, if replanning of power timelines or special pre-flight verifications of non-standard interfaces are required, then manpower plans and assignments must be changed.

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The following emerge as necessary requirements for implementation of the QIB concept:

- Reservation of a modest **resource envelope** into which all QIB activity must fall;
- Provision of **standard interfaces** which are equivalent to a common industry standard and which must be met by all QIB users; and,
- Provision by top-level NASA space infrastructure managers (i.e., Associate Administrators) of adequate intermediate management and support personnel to facilitate QIB research, and promotion incentives for those personnel to implement aggressively QIB experiments.

The characteristics of QIB research and the requirements that must be met if QIB is to be implemented as an operational policy are not unique to Space Station. They can and do apply equally well to the Space Shuttle/Spacelab as a platform for the conduct of space research (see Section V).

The Study Group recognizes the need for and strongly advocates the establishment of a separate proposal queue for QIB research on Space Station. Given the requirement to process a large number of experiments through the system, and the highly restrictive resource access suggested by the Study Group for QIB activity, it is felt that an independent, limited queue is essential. The Study Group endorses peer review of any such proposals to assure that QIB research is of the highest merit and that use of the QIB mode of operation is justified on and consistent with the criteria to be defined by the efforts mandated in Recommendation 4 (Section I).

IV. SPACE STATION AND QIB RESEARCH

The Space Station offers a uniquely exciting opportunity for establishing a vigorous QIB program within NASA. This opportunity stems from a variety of factors.

The resources (e.g., crew time, power, etc.) to be available on the Station are unprecedented and will exist for a prolonged duration. Until now, resources to support space experiments have been very restrictive and the limited duration of manned missions has demanded detailed and total commitment of the available resources to achieve maximum return from any mission. Although the demand for resources on the Station will surely grow, the extended life of the Station should eliminate the necessity to operate continually at 100 percent capacity. Indeed, it is neither desirable nor possible to maintain the frenzied pace of ground planning and on-orbit execution, so characteristic of past manned missions, over the 20 - 30 year life of the Station. Consequently, resources will be available and, if properly managed, a portion can be reserved for QIB research.

The experiment interfaces on the Station will be clearly known and thoroughly tested after an initial break-in and de-bugging period. An important and previously unavailable advantage to doing space research will result from this knowledge. Historically, when experiment and spacecraft first meet many interfaces do not work. This is because mistakes have been made on both sides of the interface. But, with the Station, interface knowledge and control should eliminate a major source of interface mismatch. The availability of certified ground simulators would provide an unprecedented opportunity for an experimenter to exercise full control over the manner in which compatibility is assured for his experiment.

A major problem in the conduct of space research is the lack of frequent access to space. This situation is exaggerated by the grounding of the Shuttle fleet, but the problem existed before the Challenger accident and it will continue into the foreseeable future following full resumption of STS operations. The Space Station can help to alleviate this problem by taking advantage of its combination of permanent crew availability and its continuous operations. Prior to Space Station and its potential for on-orbit storage capability, research payloads had to await dedicated launches, particularly if the subject of the investigation was a specific event, or if the experiment was part of a multi-payload coordinated investigation. The Space Station will make it possible to launch QIB payloads on a "space available" basis for storage and subsequent "convenient" deployment on or from the Space Station. It should be stressed that this "opportunity mode" of implementing QIB is in addition to the guaranteed resources identified in Conclusion #2 and called for in Recommendation #1.

Thus, use of Space Station as a transportation node could lead to far greater efficiency in the nation's overstressed space transportation system. It would also address the second general objective of QIB research (Section II).

Finally, there is the pragmatic point that the Space Station Program is in its formative phases. This affords NASA an excellent opportunity to establish the management commitment and mechanisms that will be necessary to successfully and vigorously implement a QIB research activity. These attributes can be built into the initial program structure rather than retrofitting them into an existing operational system (as is the case with the Shuttle).

V. QIB RESEARCH DURING TRANSITION TO SPACE STATION

It is important to gain as much experience as possible concerning QIB research prior to operation of the Space Station. A wide range of research opportunities involving, for example, balloons and sounding rockets should be exploited. The Space Shuttle has significant potential to gather useful data in a QIB research mode, and to provide valuable operational testbed experience for QIB research on the Space Station.

Aspects of the QIB concept are not new to NASA. Many examples may be found in the context of the Shuttle Program. When orbiter glow was first discovered on STS-3, and scientists realized that this might have serious consequences for space optical systems, a research program was undertaken to study the phenomenon. That program has been extremely successful. Experience on early Shuttle flights indicated that Space Adaptation Syndrome was more widespread than previously anticipated, posing uncertain consequences for future space operations. In response to this uncertainty, a series of successful life science research projects were initiated (Detailed Supplemental Objectives) beginning with STS-7.

Clearly, NASA is able to respond rapidly to address unplanned research activities. However, this response has always been ad hoc in character and usually committed to and driven by the highest levels of management in the Agency.

The Study Group strongly recommends that NASA undertake a QIB testbed activity using the Shuttle. Speaking in general terms it is recommended that a limited, but institutionalized program be begun that would make available early flight opportunities to a small number of carefully chosen projects for flight on Shuttle. The level of resources envisioned for the Shuttle QIB program is one middeck locker along with one or two GAS cans per flight. This level of resource should be set aside generically in the Shuttle manifest activity without requiring exact knowledge of what the payloads might be. A review team comprised of individuals from the Shuttle payload integration and crew offices would review any proposals to the Shuttle QIB program from the perspective of safety and crew operations, while appropriate technical review would be provided by the user code (e.g., Code E) associated with the proposal.

The Shuttle QIB program suggested here would afford an opportunity to put in place and test management by space infrastructure providers (e.g., Code M at NASA Headquarters) of dedicated resources for QIB research, as well as a means to assess and refine management by user sponsors (e.g., Codes C, E, and R at NASA Headquarters) of a special queue for QIB research.

CONCLUSION 3: The establishment of a user support infrastructure dedicated to QIB is required in order to implement effectively the QIB concept.

The Study Group examined previous space research opportunities from the perspective of lessons learned. A key lesson in this regard is that if a concept such as QIB is to be implemented successfully, an operational infrastructure dedicated specifically to supporting QIB research must be established. Furthermore, the individuals responsible for providing this support function (mainly middle-level managers within NASA) should receive job performance incentives geared at establishing a robust QIB program. Specifically, the Study Group recommends:

> **"That the Office of Space Station and the Office of Space Flight establish management structures that contain elements dedicated specifically to the support of QIB research on the Space Station and on the Space Shuttle."**

CONCLUSION 4: The QIB concept can be implemented effectively only for users placing a minimal draw on system resources and working to a well-specified and rigorously controlled set of interfaces.

The Study Group recognized that QIB research could not dominate Space Station usage; QIB must utilize only a modest, albeit guaranteed, portion of Space Station resources. The Group also concluded that an equally important aspect of QIB is the extent to which QIB activity perturbed Space Station resources, interfaces, and management structure. This led to the recommendation:

> **"That a standard set of rigidly-controlled interfaces be developed and clearly documented for QIB payloads on the Space Station."**

A significant conclusion reached by the Study Group is that its efforts mark the beginning, rather than the end, of the study of an important new era in the conduct of space research. While the Study Group was able to identify the general framework of what NASA needs to do to make QIB space research a reality, it was not able to proceed to the next level of detail. Consequently, the Study Group recommends:

> **"That the NASA Space Station user program offices (Codes C,E, and R) define the classes of activity and general technical requirements for QIB research in their programs, and that these offices, working with the Office of Space Station, develop a management plan, by the time of Space Station CDR, for supporting a special QIB research queue for Space Station."**

VI. CONCLUSIONS AND RECOMMENDATIONS

The charter of the Space Station "Quick is Beautiful" Study Group was to examine whether the Space Station planned by NASA to be operational in the mid 1990s could enhance the nation's ability to conduct an important class of space research activities, and to make recommendations to the Associate Administrator for the Office of Space Station regarding implementation of operational and/or hardware mechanisms to permit effective use of Space Station for this type of research. These activities, popularly referred to by the phrase "Quick is Beautiful" (QIB), involve small-to-moderate size space experiments that can be developed quickly and inexpensively, and which in some cases need relatively rapid initial deployment and/or reflight.

The Study Group reached four major conclusions and makes a like number of top-level recommendations to NASA.

CONCLUSION 1: The planned Space Station, with its unprecedented level of on-orbit resources (e.g., permanent crew, power, pressurized volume, and space for attached payloads) provides an **enabling** capability for the conduct of QIB research.

> This Conclusion is important because it reaffirms the tremendous potential of the Station to advance this much-needed aspect of the nation's space research program. The Study Group recognized that because NASA would be committing significant resources to the Station, there would be an excellent opportunity to utilize those resources creatively in a manner never before possible in the space program.

CONCLUSION 2: The concept of Space Station QIB research can be implemented only if there is a **guaranteed availability of resources**, both on-orbit and in transportation to orbit.

> The Study Group recognized that inherent in successful implementation of the QIB concept is the notion of guaranteed resources. It is only with assurance of resource availability that the planning and system overhead associated with planning can be kept to a minimal and uniform level. In view of the need to have many organizational elements within NASA commit to this doctrine of guaranteed resources, the Study Group makes the following recommendation:
>
> > **"That NASA enunciate an Agency policy (i.e., at the Administrator level) that guarantees the availability of at least 5 percent of the total resources of the Space Station and its supporting logistics system to the conduct of QIB research."**

The nature of QIB research is such that much of what is recommended in this report is of an operational character. Although there are clearly hardware and software implications associated with a robust QIB activity, the Study Group concluded that an enlightened mode of operations is the major enabling factor in realizing a successful QIB program. Consequently, the recommendations made here are to both user and service provider offices within NASA.

The importance of operations identified here echoes the findings of a report published in August of 1987 summarizing Space Station Science Operations Management Concepts. That report gave the findings of a study conducted jointly for the Office of Space Science and Applications and the Office of Space Station. It was in response to a request from the U.S. House of Representatives' Committee on Science, Space, and Technology. That Study concluded that "the ultimate success of the Space Station as a multi-purpose scientific research facility will be dependent upon the effective management of the overall science operations process."

Finally, the Study Group remarks on two of the truly seminal attributes of the Station; its sheer size, and its ability to evolve with time in response to changing user requirements. The size of the Station and the fact that the truss structure can be used to support a wide variety of attached payloads, a class of payloads that could benefit from a QIB mode of operation, presents great opportunities to space research communities. It is the availability of attachment points permanently on orbit, with crew nearby, that makes the Space Station markedly different from either the planned "Commercially Developed Space Facility", or the Soviet "MIR" station. In this regard,

> **the Study Group urges NASA to establish both a greater number and variety of attachment points on the Phase I Space Station.**

The Space Station is representative of a new way of conducting research in space, a way that moves from the traditional "mission" perspective of NASA toward the traditional "facility" perspective of ground-based institutions. A key aspect of this transition is that NASA can, indeed must, make evolution of the Space Station as a facility important in its planning. In this regard,

> **the Study Group urges NASA to continue a strong evolutionary component of the Space Station Program, and to assure that the evolving needs of QIB research are considered fully in planning for Space Station evolution.**

Appendix A

Membership List

Dr. Joe Alexander	NASA Headquarters
Mr. James Barrowman	Goddard Space Flight Center
Dr. John-David Bartoe	NASA Headquarters
Dr. David C. Black (Chairman)	Ames Research Center
Dr. Charles R. Chappel	Marshall Space Flight Center
Dr. Chris Chow	3M Space Research Laboratory, Minneapolis, MN
Dr. Anthony Deloach	Marshall Space Flight Center
Mr. John Egan	The Egan Group, Washington, DC
Dr. Ken Frost	Goddard Space Flight Center
Dr. Owen Garriott	Teledyne Brown Engineering, Huntsville, AL
Mr. Ted Goldsmith	Goddard Space Flight Center
Dr. Jeff Hoffman	Johnson Space Center
Mr. Gordon Johnston	NASA Headquarters
Dr. Dick Keefe	NASA Headquarters
Dr. Donald Liebenberg	National Science Foundation
Dr. Jay Moskowitz	National Institutes of Health
Dr. Stan Shawhan	NASA Headquarters
Dr. Charles Walker	McDonnell Douglas Corporation, Washington, DC

Appendix B

Bibliography of Supporting Documentation

1. "Report of the NASA Advisory Council Shuttle Science Working Group" by Stan Shawhan, September 1984.

2. "Space Butterflies and Other Speculations" by Freeman Dyson, November 1986 Volume of Science 85, pages 127-130.

3. "Lessons for the Space Station: JPL's Perspective on the Shuttle Payload Process", JPL D-3891, March 1987.

4. "Space Station User Documentation: Lessons from the Space Shuttle", JPL D-4487, June 1987.

5. "Resource Categories for Space Station Activities Planning" by R.L. Staehle and R. Cassingham, Internal JPL publication, July 1987.

Wednesday, May 13, 1987 - Lewis Room - Capital Holiday Inn

8:30	-	Continue Working Team Meetings	All
9:30	-	Report of Working Team 1/Discussion	All
10:30	-	Report of Working Team 11/Discussion	All
11:30	-	Action Items, Next Meeting Date	
12:00	-	Adjourn	

Wednesday, September 9, 1987 - Gemini Room - Capital Holiday Inn

8:30	-	Review of Agenda	J. Alexander
9:00	-	Space Station Operations Task Force	G. Paules/G. Anikis
10:15	-	Keller Study	J. Bartoe/ M. Kinsley
11:15	-	Discussion	
1:30	-	QIB Example	F. Spross
2:30	-	Discussion	
3:00	-	Discussion of QIB Questionnaire	C. Walker/J. Egan
4:00	-	Draft Outline for Final Report	O. Garriott/ J. Hoffman

Thursday, September 10, 1987 - Gemini Room - Capital Holiday Inn

9:00	-	Review of Questionnaire	C. Walker
10:00	-	Assignment of Action Items	J. Alexander
11:00	-	Wrap-up	
12:00	-	Adjourn	

Thursday, October 29, 1987 - Crystal Gateway Marriott - Crystal City, VA

8:30	-	Organizational Remarks	D. Black
8:45	-	Review of Survey/Questionnaire Material (30 Min-Includes Discussion-each speaker)	T. Goldsmith G. Johnson D. Liebenberg O. Garriott
11:00	-	Summary/Discussion of JPL "Lessons Learned"	R. Staehle
1:00	-	Review of Draft Report Sections 1-3	D. Black
3:15	-	Discussion of Sections 4-6 of Report - Emphasis on "Recommendations" - Action Items	All
5:30	-	Adjourn	

Appendix C

Study Group Meeting Agendas

Monday, April 20, 1987 - Mercury Room - Capital Holiday Inn

9:00	-	Welcoming Remarks	A. Stofan
9:15	-	Study Objectives, Products, Schedule	D. Black
9:30	-	Shuttle Science Report	S. Shawhan
10:30	-	Hitch Hikers	T. Goldsmith
10:50	-	Spartans	
11:10	-	Spacelab	
11:30	-	Commercial Perspectives	C. Walker/J. Egan
11:50	-	Crew Perspectives	J. Hoffman
1:30	-	Current Space Station Plans	
2:00	-	Space Station Science Operations	
2:30	-	General Discussion	All
3:15	-	Working Groups	All
5:00	-	Adjourn	

Tuesday, April 21, 1987 - Mercury Room - Capital Holiday Inn

9:00	-	Working Group Reports/Discussion	Group Leaders
10:50	-	Review of Study Objectives	J. Alexander
11:30	-	Topics and Assignments for Meeting #2	D. Black
12:30	-	Adjourn	

Tuesday, May 12, 1987 - Lewis Room - Capital Holiday Inn

8:30	-	Opening Remarks	D. Black
9:00	-	Discussion of Background Data - What Models? - What and how much information? - Etc.	All (Led by J. Alexander)
10:40	-	Discussion of QIB Categories & Parameters - Market/User Survey - Free Flyers, attached, pressurized - Etc.	All (Led by J. Barrowman)
1:00	-	Review Scope & Duration of Study	All
2:00	-	Break into Working Groups - Team 1: Background Data - Team 11: QIB Categories & Parameters	
5:00	-	Adjourn	

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